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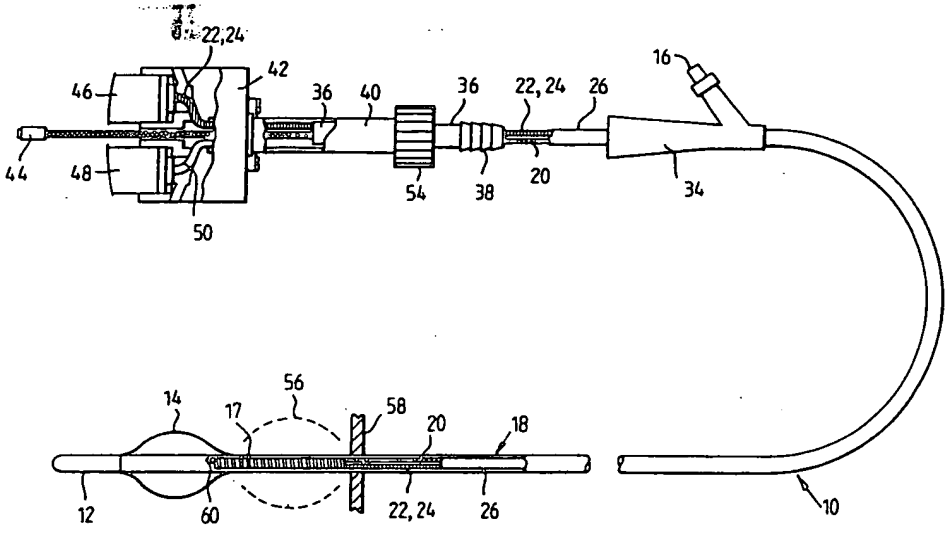

(57) Abstract

Apparatus for microwave thermal treatment comprising a probe, a microwave antenna support structure for locating the antenna within the probe near a distal end thereof, the support structure comprising means engaging the probe at a proximal end thereof and adjustment means for effecting controlled relative movement between the engaging means and the support structure whereby to adjust the longitudinal position of the antenna relative to the probe. The support structure further comprises a duct which together with the interior of a disposable catheter forming the probe provides a means of circulating coolant through the catheter externally of the structure.

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Microwave Treatment Apparatus

This invention relates to microwave treatment apparatus, particularly a catheter and to a reusable applicator assembly for use with a disposable catheter.

The use of microwave heating is known for the treatment of both benign and malignant conditions. In particular disorders of the prostate may be treated by means of a microwave applicator contained in or carried upon a transurethral catheter - see for example European patent specifications numbers 0 246176, 0 459535 and 0 462302.

However current transurethral and other small-diameter microwave catheters suffer from a number of disadvantages, amongst which are that they are not re-usable without sterilisation, and that it is difficult to position the microwave applicator at the optimum location for most effective and safest treatment. The latter problem is particularly significant with transurethral microwave catheters; incorrect location of the applicator may result in injury to the lower urethral sphincter which could render the patient incontinent.

The present invention in its several aspects has amongst its objects the provision of a microwave applicator in a catheter or a reusable assembly therefor which avoids one or both of these prior-art disadvantages.

In one aspect the invention provides an assembly for insertion in a probe to form a microwave thermal treatment device, comprising a microwave antenna and support structure for locating the antenna within the probe near a distal end thereof, the support structure comprising means for engaging a proximal end of the probe and adjustment means for effecting controlled relative movement between the engaging means and the support structure whereby to adjust the longitudinal position of the antenna within the probe.

In another aspect the invention provides apparatus for microwave thermal treatment comprising a probe, a microwave antenna support structure for locating the antenna within the probe near a distal end thereof, the support structure comprising means engaging the probe at a

proximal end thereof and adjustment means for effecting controlled relative movement between the engaging means and the support structure whereby to adjust the longitudinal position of the antenna relative to the probe.

In a third aspect this invention provides a reusable microwave applicator assembly for use in thermal treatment and adapted for use with a disposable catheter, the assembly comprising a microwave antenna, support structure for removably locating the antenna in the interior of the catheter near a distal end thereof to be introduced into a patient's body, said support structure comprising a duct which together with the interior of the catheter provides a means of circulating coolant through the catheter externally of the support structure.

In the last-mentioned aspect there also may be means for adjusting the longitudinal position of the antenna within the catheter.

The support structure may comprise at least one tube forming said duct, and a sleeve wherein the at least one tube and an electrical conductor for the antenna are contained.

The antenna may be of helical form, and the said duct may extend at least to the tip of the antenna.

There may be a ridged plug for engaging the proximal end of the catheter to form a liquid-tight seal therewith.

The adjustment means may comprise a member within which the support structure is longitudinally movable, and means for engaging the member to constrain the support structure against movement, the member being connected or connectable to the catheter or probe.

The ridged plug may be carried by the member.

The invention also provides microwave thermal treatment equipment comprising an applicator assembly or apparatus as set forth above, a source of microwave frequency electric power and means for operatively connecting said source to the assembly or apparatus.

The invention will now be described with reference to the accompanying drawings, wherein;

Figure 1 shows a reusable microwave applicator assembly according to the invention;

Figure 2 is an enlarged and partially disassembled view of the

assembly of Figure 1;

Figure 3 and 4 are sections through Figure 2 on lines 3-3 and 4-4 respectively;

Figure 5 is a side elevation of the assembly of Figure 2, and

Figure 6 is an enlarged view of part of the assembly of Figure 1.

Referring to Figure 1, the apparatus comprises a probe, specifically a transurethral catheter 10 having a blind distal end 12 (ie having no drainage holes) and a balloon 14, inflatable in a conventional manner via an inflation duct from an inflator connector 16.

A microwave applicator comprises a transmitting antenna 17 formed of helically wound copper tape, dimensioned as is known in the art to operate at an allocated medical microwave frequency (eg 434 MHz or 904/915 MHz or other appropriate frequency).

Referring also to Figures 2 to 6 the antenna 17 is carried on a support structure 18 consisting of a microwave coaxial conductor 20 and two ptfe tubes 22,24 arranged in a triangular configuration (Figure 4) and encased within a heat-shrink sleeve 26.

The sleeve 26 extends to the antenna 17 as shown in Figure 4; it is shown partially removed in Figure 1 only for reasons of clarity. At the antenna the outer casing of the conductor 20 is removed and the inner screened lead 28 is connected to the adjacent end of the antenna. The screen lead 30 is sleeved in a piece of ptfe tube 31 and together with the pipes 22,24 are encased in a further short piece of heat shrink sleeve 32 on which the copper tape forming the antenna 17 is wound.

The support structure 18 extends back down the catheter to its proximal end 34 and through a tube 36. The bore of the tube 36 is significantly larger than the diameter of the structure 20, so that a flow of coolant (eg deionized water) can also pass through the bore as hereafter described. The tube 36 has a conical ridged plug 38 which can be inserted in the correspondingly-shaped proximal end 34 of the catheter 10 to form a liquid-tight seal.

The tube 36 in itself telescopically received in a tubular portion 40 of a manifold 42 within which the heat-shrink sleeve 26 terminates; (the sleeve is again shown foreshortened in Figure 1 for clarity). The microwave conductor 20 is taken out through the manifold 42 to a

suitable microwave-frequency connector 44. The connector may alternatively be mounted in the manifold 42.

The pipes 22,24 are taken through the tube 40 to a cooling water inlet connection 46. A cooling water outlet connection 48 communicates via a pipe 50 with the interior of the tube 40 and thus with the tube 36, permitting cooling water to flow out of the interior of the catheter to the outlet 48. The conductor 20 and the tubes 22,24 are potted with epoxy resin within the manifold 42 in a conventional manner, and thus are firmly fixed therein.

The end of the tubular portion 40 carries a clamping nut 54 on a threaded portion (not shown) together with a rubber sealing washer between the nut and the end of the tube 40. The washer when axially compressed by the nut 54 expands radially inwardly whereby to grip the tube 36 within it so that the parts 18, 36 and 42 cannot move longitudinally relative to each other.

The antenna 17 is thereby fixed longitudinally in the catheter when the clamping nut is tightened.

An additional separate blind conduit, (not shown) preferably is provided in the catheter 10 to contain a thermocouple or other temperature sensor adjacent the antenna, together with its electrical connection, so that the temperature of the tissue in contact with the catheter during microwave treatment may be monitored.

Preferably the additional conduit is disposed along the outside of the catheter 10.

In use, the re-usable assembly consisting of the antenna 17, support structure 18, tube 36 and manifold etc 40,42 are inserted in the disposable catheter 10, the latter having been sterilised. After insertion of the thermocouple in its conduit the catheter is introduced into the patient's urethra until the balloon portion 14 enters his bladder. The balloon is then inflated in the conventional manner to retain the catheter in position. When the catheter has been so inserted, the approximate position of the patient's prostate is shown dotted at 56, and that of the lower urethral sphincter sybolically at 58.

The position of the antenna relative to these organs is determined

by any suitable technique eg ultrasonic imaging, and any necessary adjustment to its position is made by loosening the clamping nut 54 and sliding the manifold 42 and the support structure 18 relative to the tube 36 which is fixed in the proximal end of the catheter 10. When the position of the antenna is correct, the clamping nut is tightened. The necessary water connections 46,48 and the thermocouple connection are completed. The antenna 17 is connected via connector 44 to a source of microwave power (not shown) of appropriate authorised medical frequency suited to the dimensions of the antenna.

Alternatively the catheter may first be introduced into the urethra and the position of the postate and lower sphincter found relative to the end of the catheter by any suitable means eg ultrasound or by a fibre-optic probe introduced into the catheter. The correct length of insertion of the structure 18 and antenna 17 can then be determined, and the telescopic tubes 36,40 adjusted accordingly. A graduated scale may be provided on the tube 36 for this purpose. The antenna is then introduced into the catheter and the plug 38 secured in the proximal end 34 thereof.

During microwave therapy, cooling water is passed along the tubes 22,24 and returns down the interior of the catheter to the outlet 48. If desired the distal ends of the tubes 22,24 may be bent as shown at 60 (Figures 1 and 6) so as to impart increased turbulence to the water issuing from them, improving heat transfer from the walls of the catheter and thereby from the tissue in contact therewith. The tubes 22,24 extend at least to the end of the antenna, and preferably slightly beyond towards the end of the catheter.

Upon completion of treatment the catheter is withdrawn from the patient and discarded, the applicator assembly being retained for re-use.

It will be appreciated that the tubes 22,24 may be replaced by a single tube or by several tubes. However two tubes have the advantage of producing a conveniently-shaped structure 18 with the conductor 20, of approximately triangular section, as can be seen from Figure 4.

Although described in the context of a transurethral catheter it will be understood that the invention is applicable also in other catheters or probes for insertion into the body.

Claims

1. An assembly for insertion in a probe to form a microwave thermal treatment device, comprising a microwave antenna and support structure for locating the antenna within the probe near a distal end thereof, the support structure comprising means for engaging a proximal end of the probe and adjustment means for effecting controlled relative movement between the engaging means and the support structure whereby to adjust the longitudinal position of the antenna within the probe.

2. Apparatus for microwave thermal treatment comprising a probe, a microwave antenna support structure for locating the antenna within the probe near a distal end thereof, the support structure comprising means engaging the probe at a proximal end thereof and adjustment means for effecting controlled relative movement between the engaging means and the support structure whereby to adjust the longitudinal position of the antenna relative to the probe.

3. A reusable microwave applicator assembly for use in thermal treatment and adapted for use with a disposable catheter, the assembly comprising a microwave antenna, support structure for removably locating the antenna in the interior of the catheter near a distal end thereof to be introduced into a patient's body, said support structure comprising a duct which together with the interior of the catheter provides a means of circulating coolant through the catheter externally of the support structure.

4. An assembly as claimed in Claim 3, wherein the support structure comprises at least one tube forming said duct, and a sleeve wherein the at least one tube and an electrical conductor for the antenna are contained.

5. An assembly as claimed in Claim 3 or Claim 4, wherein the antenna is of helical form.

6. An assembly as claimed in any of Claims 3 to 5, wherein the said duct extends at least to the tip of the antenna.

7. An assembly as claimed in any of Claims 3 to 6 comprising a ridged plug for engaging the proximal end of the catheter to form a liquid-tight seal therewith.

8. An assembly as claimed in any of Claims 3 to 7 comprising means for adjusting the longitudinal position of the antenna within the catheter.

9. An assembly or apparatus as claimed in Claim 1, 2 or 8, wherein the adjustment means comprises a member within which the support structure is longitudinally movable, and means for locking the support structure relative to said member.

10. An assembly as claimed in Claims 7 and 9, wherein the member within which the support structure is longitudinally movable is a sleeve which comprises the said ridged plug.

11. An assembly or apparatus as claimed in any of Claims 1, 2, 8, 9 or 10, comprising means for indicating the relative positions of the engaging means and the support structure.

12. An apparatus or assembly substantially as herein described with reference to and as shown in the accompanying drawings.

13. Microwave thermal treatment equipment comprising apparatus or an assembly as claimed in any preceding claim, a source of microwave frequency electric power and means for operatively connecting said source to the apparatus or assembly.

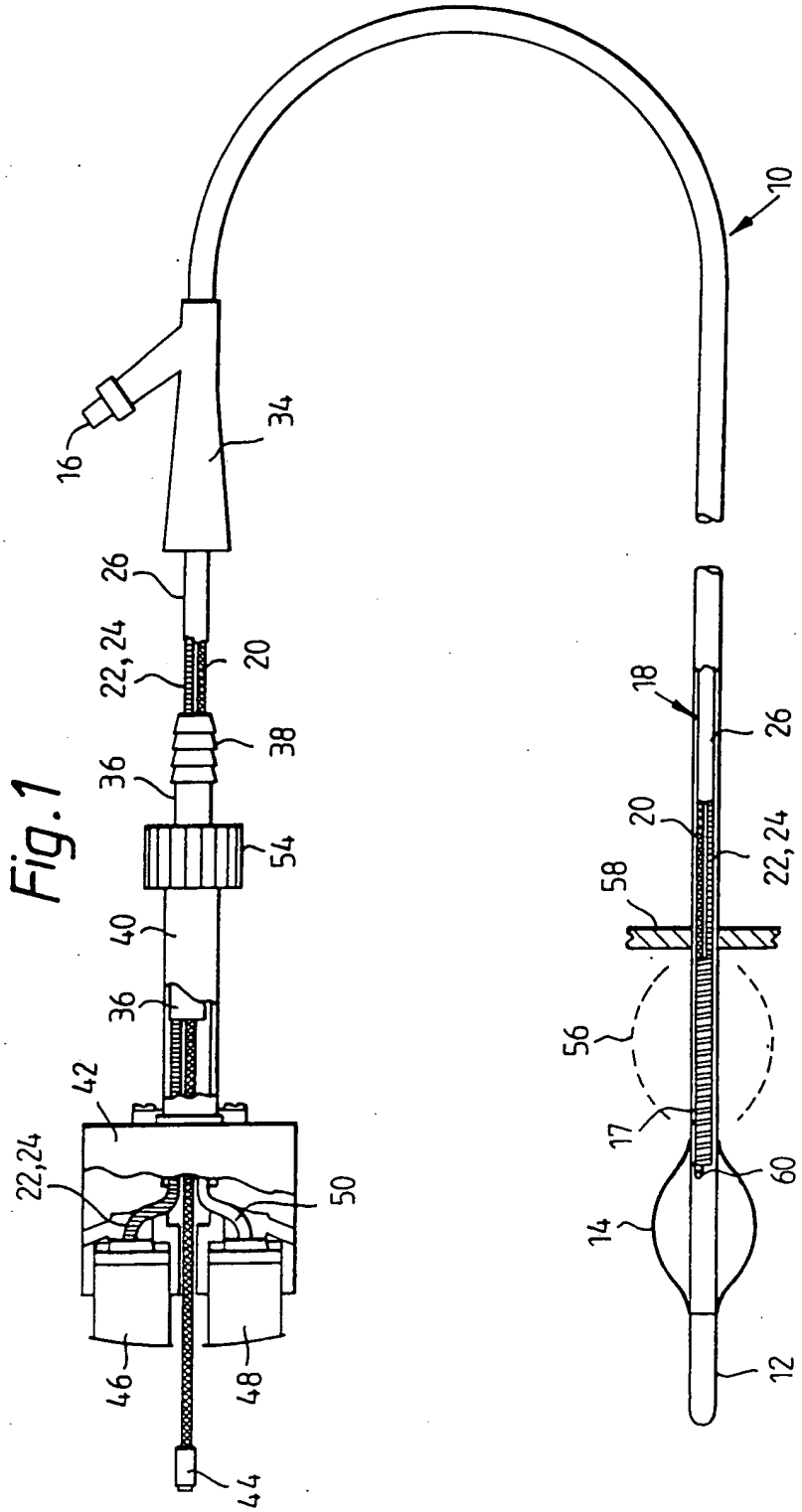
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Fig. 1

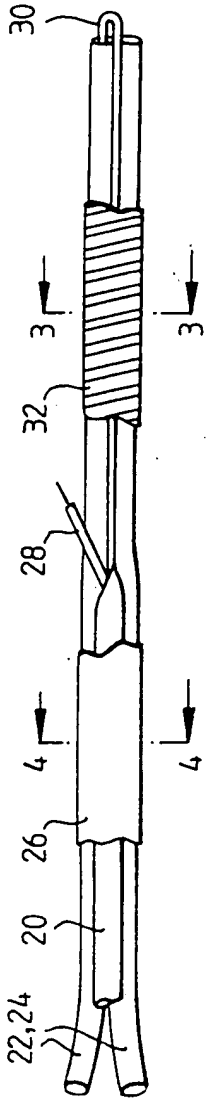
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Fig. 2

Fig. 3

Fig. 4

Fig. 5

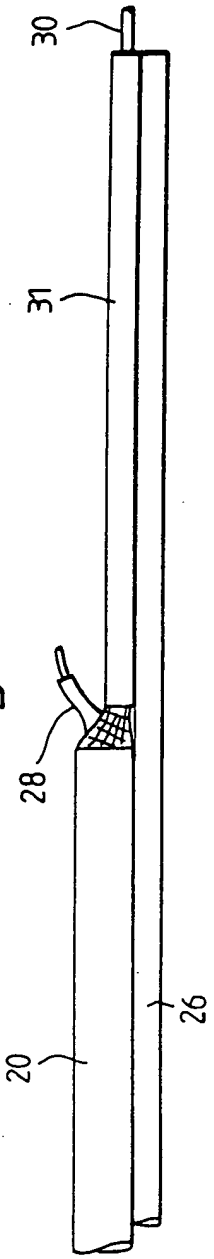
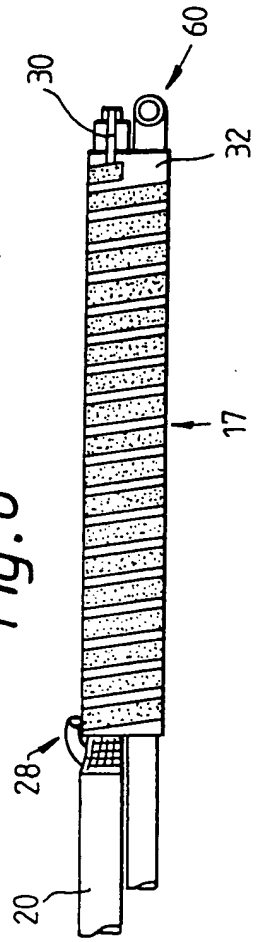


Fig. 6



INTERNATIONAL SEARCH REPORT

Inter ıal Application No
PCT/GB 93/01439

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 A61N5/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 A61N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 248 758 (BIODAN MEDICAL SYSTEMS LTD.) 9 December 1987 see the whole document	1
X Y	EP,A,0 372 100 (MICROTHERMIA TECHNOLOGY INC.) 13 June 1990 see column 9, line 40 - column 10, line 20; figures 4,5	1,12,13 9-11
Y	US,A,4 795 434 (D.KUJAWSKI) 3 January 1989 see the whole document	9-11
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO,A,92 10932 (MICROWAVE MEDICAL SYSTEMS INC.) 9 July 1992 see the whole document -----	3-5

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter al Application No
PCT/GB 93/01439

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